frontiers | Frontiers in Developmental Psychology

TYPE Original Research
PUBLISHED 12 October 2023
DOI 10.3389/fdpys.2023.1235621

OPEN ACCESS

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RECEIVED 06 June 2023
ACCEPTED 18 August 2023
PUBLISHED 12 October 2023

CITATION
Ramirez AG, Herbst E and Golinkoff RM (2023) Maternal beliefs about infant-directed speech misalign with interactions with their infants. *Front. Dev. Psychol.* 1:1235621. doi: 10.3389/fdpys.2023.1235621

Maternal beliefs about infant-directed speech misalign with interactions with their infants

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Introduction: Infant-directed speech (IDS) refers to how people in many societies talk with young children. Compared to speech directed to an adult (ADS), IDS includes a slower rate, fewer words per utterance, higher-than-average pitch, and elongated vowels. Although many benefits are associated with using IDS, there is little information on what parents think about IDS. The current study asked: (1) How do mothers conceptualize IDS; (2) Is there an alignment between mothers' IDS beliefs and their speech register when teaching a new word to their child; and (3) How do mothers' IDS beliefs associate with children's expressive language and performance on a word learning task?

Methods: Fifty-three mothers and their 15- to 21-month-old monolingual English-reared infants (M_{age} = 17.92, SD = 1.99, 23 males) participated. Mothers were asked to teach their child a novel word and to complete the Parent Language Belief Questionnaire (PLBQ). Mothers' IDS was recorded as they taught their child a novel word and was compared to their ADS from interacting with the experimenter.

Results: Findings revealed that mothers had mixed beliefs about their use of IDS. Yet, most mothers used IDS as they taught their child a novel word. Lastly, mothers' IDS beliefs did not predict children's language skills or word learning at test.

Discussion: The current study is the first to explore whether mothers' beliefs about their use of infant-directed speech align with their actual use of IDS. As the positive benefits between IDS and children's language development have been documented, identifying the barriers surrounding why parents may not use IDS with their children is essential.

KEYWORDS

infant-directed speech, baby talk, language, beliefs, interactions, infancy, word learning

Introduction

How can adults communicate with children to help them build a strong language foundation in infancy? The current study focused on one of the many ways parents can help children develop early language skills: infant-directed speech. Infant-directed speech (IDS) refers to how people in many Western societies talk with young children (Byers-Heinlein et al., 2021). IDS is not mispronunciations and non-words (e.g., "wawa" for water; "jammies" for Pajamas) (Kaye, 1980). Instead, IDS includes a slower speech rate (McMurray et al., 2013; Narayan and McDermott, 2016), fewer words per utterance (Martin et al., 2016), higher-than-average pitch (Fernald and Simon, 1984; Tenuta et al., 2023), elongated vowels (Uther et al., 2007), and a narrower set of vocabulary words (Henning et al., 2005) compared

to how adults speak with another adult (adult-directed speech; ADS). Of the acoustic features that are adjusted when using IDS, many studies have focused on the change in the average fundamental frequency (pitch) (e.g., Cox et al., 2023), or the average number of oscillations per second of a speech sample, expressed in Hz. There is a significant increase in average fundamental frequency in IDS utterances in comparison to ADS (e.g., Spinelli et al., 2017) across utterances as a whole, and especially on words that receive stress—as when asking questions (e.g., "Where's the DOGgy?") (Eady and Cooper, 1986). This prosodic modification may be widespread if not universal (Fernald et al., 1989; Hilton et al., 2022), although there are cultures that do not appear to use all the features of IDS (Ochs and Schieffelin, 1984; see Broesch and Bryant, 2018; Cristia et al., 2019).

Research with event-related potentials (ERPs) shows that infants can understand maternal speech by 9-months (Parise and Csibra, 2012). IDS might be one tool that supports children's early language learning (e.g., Fernald and Simon, 1984; Golinkoff et al., 2015; Ramírez-Esparza et al., 2017; Dilley et al., 2020; Tenuta et al., 2023). For instance, in comparison to ADS, infants are more likely to differentiate between speech and background noise when the speech is presented in IDS (Barker and Newman, 2004). IDS also attracts infants' attention to speech because of its high and variable pitch (Fernald and Simon, 1984; Soderstrom, 2007; Räsänen et al., 2018; Benders and Fletcher, 2021). Past research suggests that infants prefer listening to IDS over ADS in their native language (ManyBabies Consortium, 2020; Outters et al., 2020) as well as in foreign languages (Fernald and Morikawa, 1993; Werker et al., 1994). Indeed, infants' brains appear to process IDS and ADS differently (Naoi et al., 2012; Háden et al., 2020). Using ERPs, Zangl and Mills (2007) revealed increased neural activity when 6- and 13-month-old infants heard IDS, but not ADS, aligning with more recent work with 9-month-olds (Peter et al., 2016). Part of the preference for IDS could be because infants tend to prefer affiliative behaviors, and IDS may be associated with that (Geraci et al., 2022). The use of IDS can also assist in the segmentation of words from fluent speech (Golinkoff and Alioto, 1995; Kuhl, 2004; Thiessen et al., 2005). Facilitating word segmentation is especially important during the first year of life, as detecting regularities from the linguistic environment is a first step in understanding and ultimately producing meaningful units in their native language (Saffran, 2001). These studies collectively reflect how using the IDS register supports early language comprehension (Han et al., 2023) and production (Huber et al., 2023).

Although there are many benefits associated with IDS, there is little information on how parents think about IDS. There are numerous questionnaires designed to explore how parents' beliefs around general child-rearing practices relate to children's language development across cultures (e.g., Rodriguez and Olswang, 2003; Simmons and Johnston, 2007). However, these questionnaires have few questions that directly assess what parents think about IDS. For example, Johnston and Wong (2002) designed a survey to explore differences between North American mothers (i.e., Canadian- or European-born, $n = 44$) and Chinese mothers ($n = 42$) in beliefs concerning talk with 24- to 48-month-old children. In this survey, baby talk was defined as mispronunciations and irregular words, using examples like "wawa for water." Results revealed mixed responses across cultures, with 74% of Chinese mothers and 57% of North American (i.e., Canadian- or European-born) mothers agreeing that baby talk will help children learn how to speak correctly (Johnston and Wong, 2002). Similarly, Mancilla-Martinez and Lesaux (2013) explored Latino, Spanish-speaking parents' beliefs about their children's language development in the same age range ($N = 200$). When asked the same question about baby talk, 26% percent of Latino Spanish-speaking parents agreed that baby talk can help children learn language. The design of these survey items suggests that the definition of baby talk does not align with the literature on infant-directed speech. Therefore, the current study did not use mispronunciations and irregular words in our definition of IDS.

We also considered whether parental beliefs about IDS align with their behavior when teaching a new word to their child. Parental beliefs and speech registers would align if parents who report they engaged in IDS on the questionnaire actually use IDS when teaching their child. In contrast, a misalignment would be seen if parents who report they do not engage in IDS adjust their speech register in a manner consistent with IDS when teaching their child.

The present study asks: (1) How do mothers conceptualize infant-directed speech (IDS) and its benefits or drawbacks? (2) Is there an alignment between mothers' beliefs about IDS and the speech register they use when they teach their child a new word? (3) How do mothers' beliefs about IDS contribute to children's expressive language and performance on a word learning task? We hypothesize:

1. Mothers would underestimate their IDS usage.
2. For those mothers who indicate that they do not use IDS, there would be a misalignment between mothers' beliefs and speech register. In contrast, for those mothers who do claim they use IDS, there would be an alignment between mothers' beliefs and speech register.
3. Mothers who report that they use IDS would have children with higher expressive language scores and would be more likely to learn a novel word than children of mothers who report they do not use IDS.

Materials and methods

Participants

Eighty-two mothers and their monolingual English-reared infants between the ages of 15- to 21-months participated. However, 29 participants' word learning performance was excluded from analyses due to counterbalancing issues ($n = 4$), technological issues ($n = 3$), fussiness ($n = 5$), video quality ($n = 8$), side bias (i.e., the infant looked toward one side of the screen 70% of the time; $n = 4$), or low attention (i.e., the infant looked at the screen for less than 50% of the time, n = 5). The final sample included 53 mother-child dyads (23 males, $M_{age} = 17.92$, $SD = 1.99$). On a background questionnaire, participants self-reported that they identified as White ($n = 39$, 73.6%), Asian ($n = 2$, 3.8%), Hispanic ($n = 2$, 3.8%), African American ($n = 1$, 1.9%), and of mixed race ($n = 8$, 15.2 %). We used education as a proxy for SES, as education is the proximal component of SES that likely impacts

FIGURE 1
Novel objects with object A (glorp) on the left and object B (dax) on the right.

children's language trajectories (Hoff, 2013). In our sample, one participant held only a high school degree (1.9%). Two had some college experience (3.8%). Fifteen held a bachelor's degree (28.3%). Twenty-two held a master's degree (41.5%). Thirteen received a doctorate (24.5%).

Participants were contacted through social media, recruitment platforms (i.e., Children Helping Science), and a database from a research laboratory located in the mid-Atlantic. Potential subjects were excluded if they were deaf or had a hearing impairment because the task required participants to listen to auditory stimuli. Children were also excluded if they did not hear English at least 70% of the time. Mothers indicated their child's hearing and language background when completing the demographic questionnaire. This project was approved by the University's Institutional Review Board (1548843-11).

A *post-hoc* power analysis was conducted for a multiple regression analysis with maternal beliefs as the independent variable and word learning as the dependent variable using the G*Power 3.0 program (Faul et al., 2007). Children's age was entered as a control variable. Results from the power analysis ($\alpha = 0.05$, $b = 0.80$) indicated that a sample of 68 mother-child dyads was needed to detect a medium effect ($f^2 = 0.15$). Thus, our sample was slightly underpowered with only 53 participants.

Visual and auditory stimuli

Visual stimuli included two novel household objects (see Figure 1) to ensure the child was unlikely to have seen either object prior to the study. Object A resembled a blue travel razor case (i.e., glorp). Object B was a gray spaghetti measurer with four holes (i.e., dax). Objects were labeled with nonsense words that followed English phonotactic constraints (Parish-Morris et al., 2007). The auditory stimuli were created by a female native monolingual speaker of American English who used infant-directed speech.

Procedure

Before the one-time video-chat appointment, mothers were given a consent form and a socio-demographic information questionnaire electronically via Qualtrics. The video-chat appointment included 5 blocks: ADS elicitation, children's novel object exploration, infant teaching, testing, and assessments (Table 1). Mothers were then asked to complete the Parent Language Belief Questionnaire (PLBQ; Ramirez et al., 2023) and MacArthur Communicative Development Inventory (MCDI; Fenson et al., 2000). The independent variables were mothers' beliefs and change in speech register. The dependent variable was children's word learning performance.

ADS elicitation

At the beginning of the video-chat interaction, the experimenter asked the same two questions to every mother to establish a baseline of mothers' speech register (ADS). The first question was, "What is a typical morning for you and your child like?" The second question was, "How do you read with your child?" These questions were designed to elicit at least 45 s of ADS, and the experimenter prompted conversation with the mother when necessary. If the mother gave a response that was longer than 45 s to the initial question, the experimenter skipped the second question. Mothers were told they were being recorded, though not that our focus was their speech register. Instead, mothers were told that the study was about children's word learning.

Exploration of novel objects on screen

Next, mothers and their children were introduced to the novel objects via exploration trials. In these trials, stimuli were presented on a remotely played video on the experimenter's shared screen. Research suggests that toddlers can participate and indicate their preferences when shown videos remotely (Morini and Blair, 2021). Each novel toy was individually presented sequentially for 26 seconds. Exploration trials were added to ensure that the child could see both novel objects before test and assess whether they had a preference for either novel object, potentially interfering with which object they chose in later testing trials (Hollich et al., 2000; Pruden et al., 2006). Each novel toy appeared to float across the screen from side to side, then up and down. Visual stimuli were accompanied with upbeat music with no words. The order of presentation was counterbalanced, such that half of the participants saw Object A first and half of the participants saw Object B first.

The mother teaches the child a new word

After the exploration trials, the experimenter told mothers the name of the object to teach and presented the name in writing on the screen. The object given to the mother was counterbalanced: half of the participants were taught that Object A was called a "glorp," while the other half were taught that Object A was called a "dax." Mothers and children were never given the name of the second object and only asked to teach a single name.

The mother was asked to teach their child the name of the object to both maintain their child's attention and to provide mothers

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TABLE 1 Visual and linguistic stimuli children saw in the experiment over video chat.

Trial	Left side	Right side	Time	Audio
Exploration of novel objects on screen*				
Exploration trials (Salience)			26s	Music (no words)
			26s	Music (no words)
Infant teaching block: mother teaches child new word				
			45s	Mothers were asked to teach the child the label of the toy (e.g., glorp)
Word learning test				
Introduction trial			9s	Music (no words)
Test trial 1			9s	Look! It's a glorp! That's a glorp! Wow! There's a glorp! It's a glorp!
Test trial 2: new name trial			9s	Look! It's a dax! That's a dax! Wow! There's a dax! It's a dax!
Test trial 3: recovery			9s	Look! It's a glorp! That's a glorp! Wow! There's a glorp! It's a glorp!

*Order is counterbalanced.

the opportunity to use IDS. During the 45-second infant teaching block, the child saw the novel object silently floating across the screen with the name written on the screen. Mothers were not explicitly told to use IDS or ADS.

Testing whether children learned the new word

Following the infant teaching block, children were tested. Testing included four trials: an introduction trial to show the new format in which two objects per trial appeared, followed by three testing trials (Testing Trial 1, New Name Trial, and Recovery Trial). Mothers were instructed to close their eyes to prevent influencing their infants' looking. Each trial was separated by a 2-second intertrial interval during which a video of a laughing baby appeared in the middle of the screen with background music. Its purpose was to promote looking toward the center of the screen at the beginning of each trial.

Test trials: introduction

Two novel objects were seen side-by-side on the screen for 9 seconds accompanied with upbeat music without words.

Test trial 1: mapping the new name to the correct object

Next, children were tested to see if they mapped the novel name they were taught during the infant teaching block with the correct object. The name of the object they were taught was said four times (e.g., "Look! It's a glorp! That's a glorp! Wow! There's a glorp! It's a glorp!") by the experimenter. If children correctly associated the name with the corresponding object, they should look longer at the object that the mother named during the infant teaching block than the unnamed object.

Test trial 2: new name trial

The second test trial was a rigorous test to ensure that the child mapped the novel label to the correct object and not to both novel objects (Reed et al., 2017). This time, the auditory stimuli directed the child to look at the object that was *not* named during the infant

teaching block, (e.g., "Look! It's a dax! That's a dax! Wow! There's a dax! It's a dax!"). If the child learned the name for the object that was named during the infant teaching block, they should associate this novel label (e.g., dax) with the object that was not named, possibly using mutual exclusivity (Markman and Wachtel, 1988). The child might not switch their gaze toward the other object, but hearing this novel name should disrupt their prior looking pattern if they had mapped the name *glorp* to the correct object.

Test trial 3: recovery trial

A recovery trial replicated the first testing trial, in which the auditory stimuli directed the child to look at the object named during the infant teaching block. The name for the taught object was said four times (e.g., "Look! It's a glorp! That's a glorp! Wow! There's a glorp! It's a glorp!"). If the child successfully learned the name for the novel object, they should once again look at the named object. After the testing block, the experimenter asked the mother to complete the Parent Language Belief Questionnaire and a vocabulary assessment.

Measures

Background questionnaire

Our lab's standard background questionnaire asked demographic questions such as socioeconomic status, race/ethnicity, history of ear infections and hearing problems, and language delays.

MacArthur communicative development inventory

Mothers completed the short version of the MacArthur Communicative Development Inventory (MCDI; Fenson et al., 2000), which included a 229-item vocabulary checklist appropriate for children between the ages of 16- and 30-months, to assess children's expressive language skills. Research has shown that the short version is predictive of children's language development as long as four years later (Can et al., 2013).

Parent language belief questionnaire

Mothers were also given the Parent Language Belief Questionnaire (PLBQ; Ramirez et al., 2023) regarding their beliefs about their child's language environment, reading, and technology habits, and their use of infant-directed speech. Each of these factors may play a role in children's language trajectories (e.g., Karrass and Braungart-Rieker, 2005; Frank et al., 2021; Alroqi et al., 2022). A 4-point Likert scale, ranging from *never* to *always*, was used to determine the extent to which parents agreed with 40 statements. Children's language environment was addressed in nine items associated with building language (e.g., "I answer when my child tries to talk to me") and six items that assessed parent sensitivity and responsiveness (e.g., "I let my child figure things out on their own because this is how children learn best"). Six items examined parent-child reading practices (e.g., "I use picture books to teach my child new words.") Seven items explored parents' technology use with their children (e.g., "I use my phone during mealtimes"). Lastly, 12 items assessed parents' beliefs about IDS. Table 2 shows how these 12 items were constructed based on the literature's characterization of IDS. Mothers' responses to these IDS-related items were compared with their actual use of IDS, measured from the audio and video recordings.

TABLE 2 IDS items that promote language development as supported by sample papers from the research literature.

Questions	Literature
I change my words when my child does not understand me.	Henning et al., 2005 Hirsh-Pasek and Burchinal, 2006 Gros-Louis et al., 2014
I use shorter sentences when I talk to my child than I do when talking to my friends.	Song et al., 2010
I use shorter words when I talk to my child than when I talk to my friends.	Song et al., 2010
During a typical conversation with my child, I ask lots of questions.	Blake et al., 2006 Blewitt et al., 2009 Luo et al., 2022
I use "baby talk" – my voice gets higher and more melodic when speaking to my child than when speaking to an adult.	Grieser and Kuhl, 1988 Fernald et al., 1989 Cristia, 2013
I speak more slowly when I talk to my child than when I talk to my friends.	McMurray et al., 2013 Narayan and McDermott, 2016
I repeat myself more when I talk to my child than when I talk to my friends.	McRoberts et al., 2009 Newman et al., 2016
I repeat what my child says, adding new words.	McRoberts et al., 2009 Newman et al., 2016
†I correct my child if s/he uses the wrong word.	Hirsh-Pasek and Burchinal, 2006 Gros-Louis et al., 2014
†I address my child and my adult friends with the same tone of voice.	Ma et al., 2011
†I speak to my child as I would speak to an adult; this is how they will learn to speak intelligently.	Ma et al., 2011
†I speak to my child as I speak to adults to help him or her learn proper language.	Ma et al., 2011

†Items are reverse coded.

Coding and reliability

Speech analysis

The average fundamental frequency and pitch range was extracted from the mothers' speech samples during the ADS elicitation (Time 1) and infant teaching block (Time 2) using Praat software (Boersma and Weeninik, 2018). To evaluate whether caregivers used IDS, the acoustic properties of their speech to infants was compared to when they were speaking with the adult (ADS).

Infants' eye gaze coding

Infants' looking patterns were coded in the intermodal preferential-looking paradigm (IPLP; Golinkoff et al., 2013) using Datavyu 1.3.7 (Datavyu Team, 2014). Looks were coded as left,

right, center, or away on a frame-by-frame (30 frames per second) basis. To assess the reliability of eye gaze coding, a second coder re-coded 20% of the videos and obtained strong reliability ($r = 0.99$).

For the exploration and infant teaching trials, infants' attention to the stimuli was calculated by dividing the time spent looking at the screen by the total trial length. If infants' attention was <50% of the total trial length, they were excluded from further analyses (Pruden et al., 2012). For testing trials, the dependent variable was computed by dividing children's looking time toward the target object by their total looking time to both objects (i.e., percentage looking to target or PLT; Verdine et al., 2017).

Results

How do mothers conceptualize infant-directed speech?

The twelve items of the Parent Belief Questionnaire that related to assessing mothers' beliefs about IDS contained high item-reliability (Cronbach's $\alpha = 0.83$). A variable (referenced as IDS Belief) was created by summing each mother's responses to IDS Belief items and dividing by 12, the number of IDS Belief questions. Some items were reversed-scored. Mothers' scores ranged from 0–3. A higher score indicated that mothers thought IDS was more valuable for their children's language learning while a lower score suggested that mothers did not think IDS would be helpful. Results revealed mixed responses to the IDS Belief items. Table 3 shows the percentage of mothers that often or always (scores two and three) supported the IDS item. Overall, mothers were neutral toward their use of IDS when interacting with their infant ($M = 1.72$, $SD = 0.46$, *Range* = 0.67–2.75). Mothers' beliefs did not differ according to the gender of the infant, children's age, nor language ability (as measured with the MCDI), all $ps > 0.05$.

TABLE 3 The percentage of mothers who selected "often" or "always" on IDS items.

Maternal beliefs about IDS usage	Mean (SD)	Percentages
I repeat myself more when I talk to my child than when I talk to my friends.	2.33 (0.65)	86.8
I change my words when my child does not understand me.	2.22 (0.70)	81.1
I repeat what my child says, adding new words.	2.16 (0.67)	81.1
During a typical conversation with my child, I ask lots of questions.	2.16 (0.81)	79.2
I use shorter sentences when I talk to my child than I do when talking to my friends.	1.67 (0.77)	54.7
*I speak to my child as I speak to adults to help him or her learn proper language.	1.29 (0.88)	52.9
I use "baby talk" – my voice gets higher and more melodic when speaking to my child than when speaking to an adult.	1.57 (0.85)	50.9
*I correct my child if s/he uses the wrong word.	1.47 (0.81)	47.1
*I speak to my child as I would speak to an adult; this is how they will learn to speak intelligently.	1.53 (0.81)	45.1
*I address my child and my adult friends with the same tone of voice.	1.61 (0.67)	39.6
I speak more slowly when I talk to my child than when I talk to my friends.	1.27 (0.83)	37.8
I use shorter words when I talk to my child than when I talk to my friends.	1.33 (0.82)	33.9

Scale ranged from 0 to 3 (Never, Sometimes, Often, or Always). *Items are reverse coded.

Do mothers exhibit IDS in their speech?

To examine how mothers interacted in the infant-directed communication context, we investigated how mothers' acoustic features changed when speaking with an experimenter compared to speaking with their infant. To explore changes related to speech register, we extracted the average fundamental frequency, pitch minimum, and pitch maximum in both the ADS elicitation and infant teaching block using Praat software (Boersma and Weeninik, 2018). Both blocks were at least 45 seconds long. However, the time duration of the ADS elicitation ($M = 39.68$, $SD = 3.10$, *Range* = 24.68–45.48 seconds) and infant teaching ($M = 37.95$, $SD = 5.50$, *Range* = 15.00–45.84 seconds) block still significantly differed, $t(52) = 2.145$, $p = 0.04$, $d = 0.30$.

Three one-way ANOVAs were separately conducted to compare the effect of the block (ADS elicitation vs. infant teaching) on the three dependent variables, mothers' average fundamental frequency, maximum pitch, and minimum pitch. Results revealed a significant difference in mothers' average fundamental frequency between the ADS elicitation and infant teaching block, $F_{(1, 104)} = 95.753$, $p < 0.001$, $\eta^2 = 0.48$. However, there were no significant differences in mothers' maximum nor minimum pitch across these blocks, all $ps > 0.05$. Altogether, results revealed that mothers had a significantly higher average fundamental frequency during the infant teaching block in comparison to the ADS elicitation block (Figure 2), suggesting that they spoke differently to their child when teaching a novel word than when they spoke to an adult.

For subsequent analyses, we created a difference score for each participant between Time 2 (infant teaching) and Time 1 (ADS elicitation) to examine mothers' speech register adjustment, a technique used in past work (Thiessen et al., 2005; Singh et al., 2009; Ma et al., 2011). Mothers' average fundamental frequency at Time 1 was subtracted from their average fundamental frequency at Time 2, yielding a difference score that allows us to control for individual differences. A positive difference score signifies that a mother's average fundamental frequency was higher when teaching a novel word to their child than when talking to an adult. Additionally, a smaller score signifies less change when interacting with their child. We next averaged speech adjustment scores across mothers and found that there was an average 52.15 Hz increase in fundamental frequency between the infant teaching and ADS elicitation blocks.

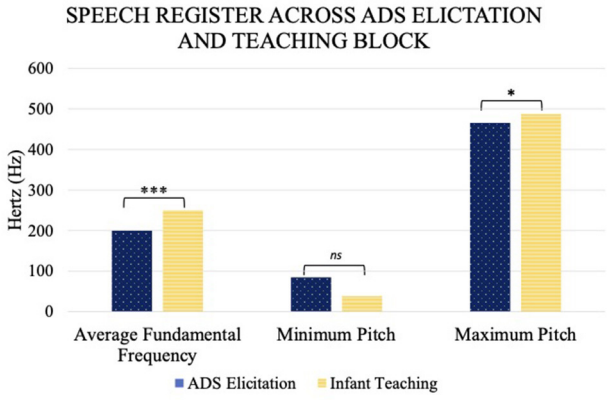

FIGURE 2
Results from three separate one-way ANOVAs to assess whether mothers adjusted their speech register between the ADS elicitation and infant teaching block. ns, not significant; $^{*}p < 0.05$, and $^{***}p < 0.001$.

Is there alignment between mothers' beliefs and the speech register used when teaching children a new word?

To answer this question, we ran several correlations. First, we found that a correlation between mothers' IDS Belief scores and their speech register adjustment scores was significant ($r = 0.28$, $p = 0.05$). To explore further, we examined how mothers' speech register adjustment scores related to how they responded to different components of the 12 IDS- items from the PLBQ. Below, we present these results by theme: beliefs about changes in speech related to prosody, word and sentence choice, and purpose.

To assess mothers' beliefs about adjusting their *prosody*—the intonation of speech—when interacting with their child, a composite score was created by adding mothers' responses to the two items and dividing by three, the number of items in this cluster. Specifically, item 11 ("I use baby talk–my voice gets higher and more melodic when speaking to my child than when speaking to an adult"), item 1 ("I address my child and my adult friends with the same tone of voice"; scored in reverse), and item 16 ("I speak more slowly when I talk to my child than when I talk to my friends") were included. Overall, mothers reported that they occasionally adjusted their prosody when interacting with their infant ($M = 1.59$, $SD = 0.69$). A correlation between mothers' beliefs about prosody and their speech adjustment score was significant ($r = 0.32$, $p = 0.02$). When looking at the items separately, only the relation between mothers' response to item 11 (melodic speaking) and their speech register adjustment score was significant ($r = 0.38$, $p < 0.01$), suggesting that mothers' change in speech register during the infant teaching block was aligned with their belief that they used a higher and more melodic voice when speaking with their child. These findings suggest that mothers may be aware that they adjust their pitch when interacting with their child but are incognizant of the extent in comparison to interacting with another adult.

The second theme included seven items that examined mothers' beliefs about how often they adjust their *words and sentences* when interacting with their infant. These items included item 20: "I repeat myself more when I talk to my child than when I talk to my friends," item 36: "I change my words when my child does not understand me," item 8: "During a typical conversation with my child, I ask lots of questions," item 28: "I repeat what my child says, adding new words," item 3: "I use shorter sentences when I talk to my child than I do when talking to my friends," item 32: "I correct my child if s/he uses the wrong word" (reverse-scored), and item 15: "I use shorter words when I talk to my child than when I talk to my friends." A composite score was created by adding mothers' responses to the seven items and dividing by seven, the number of items in this cluster. Mothers reported that they often adjusted their words and sentences when interacting with their infant ($M = 1.90$, $SD = 0.36$). There were no significant relations between mothers' responses to these items individually and their speech register adjustment score.

Lastly, our third theme is *purpose*, which includes item 6: "I speak to my child as I would speak to an adult; this is how they will learn to speak intelligently" and item 40: "I speak to my child as I speak to adults to help him or her learn proper language." Both items were reversed-scored. A composite score was created by adding mothers' responses to the two items and dividing by two, the number of items in this cluster. The relation between mothers' beliefs about their purpose in using IDS ($M = 1.41$, $SD = 0.80$) and their speech adjustment score was significant ($r = 0.31$, $p = 0.03$). When exploring the items individually, only the relation between mothers' response to item 40 and their speech register adjustment score was significant ($r = 0.33$, $p = 0.02$). Together, results suggest that mothers may talk to their child differently to help them learn language.

Do mothers' IDS beliefs predict children's expressive language scores?

A multiple regression analysis was run to assess the contribution of mothers' beliefs about IDS and their speech register adjustment score on the dependent variable, children's expressive language skills measured as the number of words they produced on the MCDI. We inserted mothers' speech register adjustment score first, as mothers' speech register adjustment has been shown to be associated with children's language acquisition in past studies (Thiessen et al., 2005; Ma et al., 2011; Cristia, 2013). This model accounted for a non-significant 4.5% of the variance in children's expressive language skills, $F_{(2, 52)} = 1.123$, $MSE = 0.025$, $p = 0.33$.

Assessing whether mothers' IDS beliefs are associated with children's word learning

Preliminary analyses

To assess how mothers' beliefs contribute to children's word learning performance, we calculated infants' percentage looking to the target by dividing children's looking time toward the target object by their total looking time to both objects (i.e., PLT; Verdine et al., 2017). Preliminary analyses revealed no differences in children's PLT related to gender or condition (all

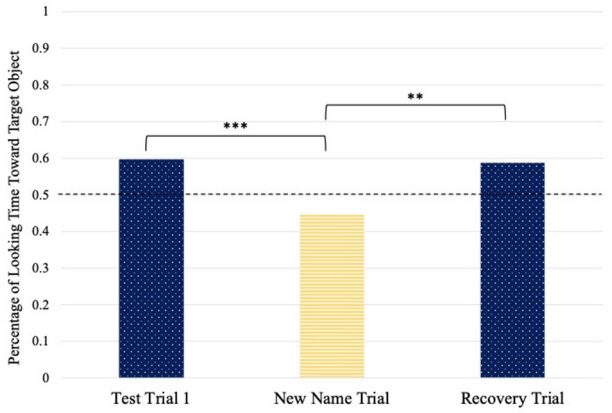

FIGURE 3
Children's percentage of looking time toward the target object during the three test trials. In each trial, items were presented side-by-side on the screen. Children were asked to look at the object whose name they were taught during test trial 1 and trial 3, the recovery trial. Children were asked to look at the object whose name they were not taught during trial 2, the new name trial. Dashed line represents chance performance. $^{**}p < 0.01$ and $^{***}p < 0.001$.

$ps > 0.05$), so the data were collapsed across these variables. We also found that children did not prefer one toy over another ($p > 0.05$). More information about preliminary analyses can be found in supplemental materials (https://osf.io/qzgst/?view_only=0dc6f33380c246ed9bf4a7c35c17e4b2).

Did children learn the word during the infant teaching block?

Although test trials 1 and 3 (the recovery trial) were identical, test trial 2 (new name trial) asked a different question. Success in the new name trial would be evidenced by disruption of prior looking patterns in test trial 1 and the recovery trial. Therefore, each test trial was analyzed individually. A repeated-measures ANOVA with one factor (trial type) and three levels (test trial 1, new name trial, recovery trial) was run. The repeated-measures ANOVA with a Greenhouse-Geisser correction determined that the children's PLT differed significantly between the three test trials, $F_{(1.573,\ 81.809)} = 9.227$, $p < 0.001$, $\eta_p^2 = 0.151$ (Figure 3). *Post hoc* analysis with Bonferroni adjustment revealed a statistically significant difference in children's PLT between test trials 1 ($M = 0.59$, $SD = 0.16$) and 2 (new name trial; $M = 0.43$, $SD = 0.19$), $p = 0.001$. Additionally, there was a statistically significant difference between test trials 2 (new name trial) and 3 (recovery trial) ($M = 0.59$, $SD = 0.24$), $p = 0.01$. However, no significant difference between test trials 1 and 3 emerged, demonstrating robust learning of the novel word because children had to remember the novel word with an intervening trial and another new object-name pair offered.

We next examined whether children's PLT score for each trial differed from chance. For test trial 1, children's PLT score was significantly greater than chance (50%), $t\ (52) = 4.151$, $p < 0.001$, $d = 0.57$. These findings suggest that infants demonstrated comprehension of the object name they were taught during test trial 1. When looking at children's PLT scores, 39 out of 53 children (73.6%) looked longer at the object mothers labeled during the infant teaching block than the unnamed object. For the new name trial, children's PLT score for the unnamed object was significantly less than chance (50%), $t\ (52) = -2.472$, $p < 0.01$, $d = -0.34$. These findings suggest that infants demonstrated mutual exclusivity, in which they switched their gaze to the object that was not named during the prior infant teaching block. Indeed, only 22 out of 53 children (41.5%) looked longer at the object that was not named during the infant teaching block at test trial 2 than the named object. For the recovery trial, children's PLT score was significantly greater than chance (50%) as well, $t\ (52) = 2.567$, $p < 0.01$, $d = 0.35$. Specifically, 36 out of 53 children (67.9%) looked longer at the object mothers labeled during the infant teaching block than the unnamed object.

A multiple regression analysis was run to assess the contribution of mothers' IDS beliefs on the dependent variable, infants' word learning performance. Mothers' IDS beliefs were inserted as the predictor variable. Test trial 1 and the recovery trial (test trial 3) were identical in that both asked the infant to find the target object while the new name trial (test trial 2) was predicted to diminish infants' attention to the target object. To increase the reliability of infants' responses (Roseberry et al., 2009), data from test trial 1 and the recovery trial were averaged and inserted as the outcome variable. Children's age was inserted as a control variable. Results revealed that mothers' beliefs around IDS did *not* contribute to children's word learning performance, $F_{(2,\ 48)} = 0.066$, $MSE = 0.03$, $p = 0.94$.

Discussion

This study sought to examine how mothers conceptualize infant-directed speech (IDS), whether there is an alignment between mothers' beliefs about IDS usage and their speech when interacting with their children, and how IDS beliefs may relate to children's language skills, word learning, or mothers' change in speech register. Although IDS is not used in all societies (e.g., Broesch and Bryant, 2018), its widespread use has been shown to enhance children's language learning (Thiessen et al., 2005; Cristia, 2013). It is essential to understand mothers' perspectives on IDS and whether they think it facilitates their children's language development. Results revealed that mothers had mixed beliefs about their use of IDS. Nevertheless, mothers used IDS, suggesting a misalignment with their beliefs. Lastly, mothers' beliefs about using IDS predicted neither children's performance on the MCDI nor children's word learning at test.

Mothers have mixed beliefs about infant-directed speech

The Parent Language Belief Questionnaire (PLBQ; Ramirez et al., 2023) is the first questionnaire designed to examine parents' beliefs about infant-directed speech. Past studies have examined parents' beliefs about "baby talk" and defined baby talk as mispronunciations and irregular words (Rodriguez and Olswang, 2003; Simmons and Johnston, 2007). However, this definition does not align with what research defines as infant-directed speech (e.g.,

Kaye, 1980). To address this, we designed 12 items on the PLBQ to assess mothers' beliefs about IDS based on how previous studies defined IDS (Henning et al., 2005; Song et al., 2010; Cristia, 2013; Narayan and McDermott, 2016). For example, we asked if mothers were likely to ask more questions (Luo et al., 2022) and use more repetition (McRoberts et al., 2009) when speaking with children than when speaking with adults. We intentionally did not include mispronunciations (e.g., "wawa" for water) in our definition of IDS.

Our first research question probed mothers' beliefs about infant-directed speech. We hypothesized that mothers would underestimate their IDS usage based on mothers' responses in past studies (Rodriguez and Olswang, 2003; Simmons and Johnston, 2007). We found that mothers had mixed responses to the IDS items. For example, only roughly half of mothers (50.9%) reported that they often or always "use baby talk–their voice gets higher and more melodic when speaking to their child than when speaking to an adult." It seems that mothers might be unaware that they naturally adjust their speech register when interacting with children.

When further exploring mothers' perceptions of how they adjust their speech with their child, we found that mothers were more receptive to IDS-items that did not focus on prosody *per se*. For example, 81.1% of mothers reported that they often or always "change their words when their child does not understand them," and 86.8% reported that they often or always "repeat themselves more when they talk to their child than when they talk to their friends." Mothers are less likely to admit to adjusting their speech register in comparison to other behaviors such as simplifying vocabulary and repetition.

In past studies, parents' knowledge of child development was associated with parents' self-efficacy, child-rearing practices, variability in linguistic input, and children's language abilities (Bornstein and Cote, 2003; Albarran and Reich, 2014). For example, Rowe (2008) explored the factors contributing to parental language input variability. Exposure to child-directed speech at 24-months was correlated with children's language skills one year later. Differences in the proportion of parents' child-directed speech were related to parents' SES, as measured by income and education. Importantly, parents' knowledge of child development mediated the relationship between parents' use of child-directed speech and SES. This suggests that parents with more knowledge about children's development, as measured by parents' performance on the KIDI (MacPhee, 2002), were more likely to use child-directed speech with their children. These findings highlight how parent cognition is often connected with parent behavior (Huang et al., 2005) and, in turn, children's development (Bornstein et al., 2018; McKee et al., 2021). Therefore, understanding how parents conceptualize IDS may provide insight into why parents might not use IDS with their children.

Mothers exhibit IDS in their speech to their children

We also considered whether mothers modified their speech register when interacting with their child compared to interacting with an adult. Variability in parents' speech register with adults and infants has been demonstrated in many studies and our findings are no different (Spinelli et al., 2017; Byers-Heinlein et al., 2021). There was a significant difference in mothers' average fundamental frequency between the ADS elicitation and infant teaching block. To further explore the extent of this difference, we created a speech register adjustment score for each participant by subtracting the average fundamental frequency during Time 1 (ADS elicitation) from Time 2 (infant teaching). An average difference of 52.15 Hz was found between the infant teaching and ADS elicitation block. These findings suggest that mothers adjusted their speech register depending on their communicative partner and align with past work in which mothers elevated their pitch when speaking with infants (Fernald and Simon, 1984; Song et al., 2010; Golinkoff et al., 2015).

Why do many parents use infant-directed speech with their young children? First, IDS may elicit and maintain children's attention (Fernald and Simon, 1984; Fernald, 1992). Indeed, Dunst et al. (2012) found that infants tend to prefer listening to IDS over ADS speech in their 34-study meta-analysis. Parents may notice that infants pay more attention to them when they use IDS.

The second possibility is that parents might use IDS to reassure their children when their physical proximity decreases (Katz et al., 1996). Adults tend to display exaggerated positive affect by smiling, widening their eyes, and raising their eyebrows when interacting with infants (Scherer et al., 1991; Swerts and Krahmer, 2010). These exaggerated facial expressions often accompany infant-directed speech (Chong et al., 2003). However, there are times when infants cannot access their parents' facial signals. For example, a parent might wash dishes or run a load of laundry while their infant plays in the next room. Infants are more likely to decipher the affectionate intention of caregivers' messages when parents use IDS than ADS (Fernald et al., 1989; Moore et al., 1997; Spence and Moore, 2003).

Third, parents may use IDS to encourage infants to participate in the conversation. The slower tempo in IDS may create an opening for infants to respond, either through gestures, babbling, or talking (Ferjan Ramírez et al., 2019). Inviting children to engage in conversational turn-taking is a key component for building language, social skills, and cognitive development (Donnelly and Kidd, 2021). For example, Hirsh-Pasek et al. (2015) examined the contributions of the quantity and quality of input in 60 parent-child dyads on children's later language development. Results revealed that the turn-taking between the mother-child dyad (i.e., "fluency and connectedness") at 24-months correlated with children's expressive language abilities one year later. Through turn-taking, parents can encourage children to take an active role in conversations, which is associated with stronger language skills (Tamis-LeMonda et al., 2014; Romeo et al., 2018).

The fourth possibility is that parents may use IDS with their children with an eye to facilitating language development (Saint-Georges et al., 2013). Parents may modify their talk according to their children's current language skills (Bruner, 1984). For example, when Bergelson et al. (2019) observed children's linguistic environments between the ages of 3- to 20-months, results revealed that the proportion of child-directed speech increased with age as adult-directed speech decreased. One hypothesis for this decrease

in ADS is that parents are detecting that their children are attuned to language and need good language models. Indeed, parents talk more to infants who have begun to talk than infants who are not talking yet (Dailey and Bergelson, 2022).

Findings from our study are consistent with several of these possibilities. Specifically, mothers used IDS to *direct infants' attention* toward the screen. They also *invited infants to engage in conversation* by encouraging infants to pronounce the target word. Lastly, we gave mothers the goal of teaching their child a novel word, allowing mothers to facilitate word learning in whatever way they chose. Many mothers adjusted their speech register to *teach* their children the novel word. However, we did not directly ask mothers why they used IDS when they taught their children a novel word.

There is misalignment between mothers' beliefs about IDS with their change in speech register

The second research question probed whether mothers' beliefs would align with their use of IDS when interacting with their child. We hypothesized that there would be a misalignment between mothers' beliefs about IDS and their speech registers, especially for those mothers who indicated that they did not use IDS. To address this research question, we averaged speech adjustment scores across mothers and observed an average increase of 52.15 Hz in fundamental frequency between the infant teaching and ADS elicitation blocks. Findings suggest that most mothers adjusted their speech register when interacting with children *regardless* of their beliefs about IDS. Although some literature observes a correlation between parental knowledge about child development and parenting practices (Huang et al., 2005), we do not see this pattern when analyzing the relation between IDS beliefs and speech behavior. In contrast, our findings revealed that mothers' beliefs about IDS do not correlate with their speech register adjustment.

Next, we broke down the IDS composite score to investigate whether mothers' speech register adjustment scores were aligned with beliefs regarding components of IDS: prosody, word and sentence choice, and purpose. Notably, mothers' speech register adjustment scores were related to their beliefs about prosody and purpose of using IDS. For example, mothers who had a higher speech register adjustment score were more likely to report that they use "baby talk–their voice gets higher and more melodic when speaking to my child than when speaking to an adult" on the questionnaire ($p = 0.02$). Interestingly, there was no relationship between mothers' speech register adjustment score and their response to other items related to word and sentence choice. There are two possibilities for why mothers responded differently to items related to prosody and word and sentence choice.

The first possibility could be that mothers believe that they should talk to children in the same way that they speak to adults in terms of word and sentence choice. Alternatively, it could be that mothers are aware that they adjust their speech when interacting with their children. However, they might be less conscious of the extent to which their speech to their child differs from the way they talk with adults, thinking the difference is small. Altogether, it seems that mothers have misconceptions about IDS. This could be due to inconsistent messaging about the use of baby talk with their children. A quick Google search of "should mothers use baby talk with kids" on March 20, 2023, yields 882,000,000 results with conflicting article titles, such as "Why baby talk is good and bad for kids," "Why should one avoid using baby talk," or "Using baby talk isn't just cute: it could help them learn to make words." Additionally, early writers framed baby talk as harmful (McCarthy, 1954), potentially creating a stigma around its use. Mothers are more likely to turn to Google for their source of information than research articles. Therefore, defining infant-directed speech and clarifying that it is beneficial for babies may be an initial step toward addressing mothers' misconceptions about baby talk.

IDS beliefs do not correlate with children's expressive language scores nor children's performance on a word learning task

Our final question assessed whether mothers' beliefs about IDS are associated with children's expressive language scores (MCDI) or children's performance on a word learning task. We hypothesized that mothers' beliefs about IDS would not relate to any of these outcome variables. Results were in alignment with our hypothesis, in that mothers' beliefs around IDS did not associate with children's expressive language scores nor children's performance on a word learning task. It seems that mothers' beliefs do not reflect what they do in real-time. In real-time, mothers engage in child-directed behaviors and elevate their speech register when talking with their children.

How the present findings can impact mother-child linguistic interactions

Most mothers in our sample used IDS when they taught a novel word to their child, even though mothers may have conceptualized IDS differently from the literature. From an evolutionary lens, these results suggest that many parents have a predisposition to use IDS with their children (Hilton et al., 2022; Schick et al., 2022). Still, the frequency of infant-directed speech varies widely in monolingual and bilingual families (Ramírez-Esparza et al., 2014; Ferjan Ramírez et al., 2022). In fact, infant-directed speech is rare in some communities (see Ochs and Schieffelin, 1984; Broesch and Bryant, 2018; Cristia et al., 2019). Thus, we cannot claim that IDS is necessary for children's language learning (Ma et al., 2011). Indeed, children in these communities develop language at the same rate as children from the United States (Casillas et al., 2020, 2021), a country that commonly uses IDS when interacting with infants (ManyBabies Consortium, 2020). Floor and Akhtar (2006) found that 18-month-old children could learn a novel word when stimuli were presented indirectly (i.e., overheard speech), presumably in ADS. However, exposure to IDS has many benefits for language acquisition, such as facilitating word segmentation (Thiessen et al., 2005), word recognition (Singh et al., 2009), and speech discrimination (Liu et al., 2003).

Additionally, infant-directed speech can be beneficial in communities where interactions with children are rare. For example, Shneidman and Goldin-Meadow (2012) explored sources of children's language input in a Mayan community and with families in the United States. Though interactions occurred far less in the Mayan community than in the U.S. sample, children's exposure to direct input by adults at 24-months was the most robust predictor of children's later vocabulary skills in the Mayan sample. Nearly all children become competent speakers in their respective communities. Therefore, although IDS is not necessary for word learning, we argue that IDS, among other aspects of the linguistic environment (e.g., eye-gaze, perceptual salience, turn-taking; Hollich et al., 2000), is a valuable tool to facilitate language development.

Our findings may be useful in existing interventions that address how parents interact with their language-learning children. For example, Ferjan Ramírez et al. (2019) examined whether coaching parents at 6- and 10-months would improve children's language skills at 14-months. Coaching included providing feedback on how parents interacted with their infant by sharing written reports and listening to recordings. Coaches also discussed the benefits of using IDS, turn-taking exchanges, and overall talk on children's language development with parents. Results revealed that parents who received coaching were more likely to increase their use of infant-directed speech than those who did not receive coaching. Furthermore, children whose parents received coaching had higher language gains than children whose parents did not receive coaching. Our findings suggest that coaches also address potential misconceptions about infant-directed speech. Addressing misconceptions may contribute to clarifying the messaging about baby talk and removing any stigma around its use.

Limitations

Although these findings have implications for adding to current interventions that build children's language skills, there are several limitations to consider. First, mothers were asked to teach a novel word to their child to prompt IDS. Mothers may exhibit more IDS than they would in an everyday context because the task was goal oriented. An avenue for future work would be to see how results align with day-to-day interactions in the home, although numerous observational studies have shown that parents use IDS (e.g., Englund and Behne, 2005; Narayan and McDermott, 2016; Kalashnikova and Burnham, 2018).

Another weakness is that our sample was largely homogeneous. As beliefs about child-rearing practices differ across cultures (Johnston and Wong, 2002; Simmons and Johnston, 2007; Mancilla-Martinez and Lesaux, 2013) and the use of IDS is not present in all societies (e.g., Broesch and Bryant, 2018), a more diverse sample might differ in their beliefs about IDS. Additionally, our sample consisted of only mothers. Further research should explore whether fathers have a misalignment between their beliefs about IDS and their behavior.

Of course, it is always possible that our questionnaire did not tap into items that would show us a relationship between beliefs about IDS and its use. Thus, future work should examine whether there are other ways to ask the questions we posed that might yield more of a relation with mothers' actual behaviors. Nonetheless, it is fascinating that mothers do not seem to report they utilize some aspects of IDS.

Conclusion

The current study is the first to explore whether mothers' beliefs about their use of infant-directed speech align with their actual use of IDS. These findings highlight mothers' mixed beliefs about using IDS. Interestingly, these beliefs appear not to relate to children's language skills or their ability to learn a novel word. During current interventions, some researchers define IDS to parents and discuss its benefits for language learning (see Ferjan Ramírez et al., 2019). Addressing parents' misconceptions about IDS might strengthen these interventions.

Data availability statement

The datasets presented in this article are not readily available because informed consent did not request permission for data sharing. Requests to access the datasets should be directed to AR, alexusgr@udel.edu.

Ethics statement

The studies involving humans were approved by University of Delaware Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

AR and RG conceptualized the idea for the project. AR developed the study methodology and materials. AR, EH, and research staff collected the data. AR and research assistants coded the data. AR conducted statistical analyses and wrote the first draft. RG and EH provided critical feedback and edits. All authors contributed to the article and approved the submitted version.

Funding

This work was supported by a University Dissertation Fellowship from the Graduate College at the University of Delaware.

Acknowledgments

We thank Alexa Bruette, Clara Hatch, Lindsay Becker, and Abigail Casalvera for their assistance with data collection and Gabriella Araneta, Evia Mascaro, and Miranda Kalafatis for coding

data. We are grateful for the parents and children who took part in the research.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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